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The second is that there should be established in our normal schools, colleges and universities thoroughly scientific courses in bacteriology. Such a course would lay the foundation of the science and place it on a par with other branches of biology, such as botany and zoology. Such departments should be prepared to do research, thereby fitting men for the special phases of the subject in technical and professional schools, and qualifying others to do research of a purely scientific nature, without reference to any particular trade, occupation or profession. The problems here are as numerous and their solutions are as taxing upon the mental forces of the investigator as they are in any branch of scientific endeavor.

The third suggestion is a plea for more scientific methods of teaching bacteriology in our professional schools. The course should, as a rule, be lengthened and the theoretical teaching supplemented by as much practical work as possible.

We should in view of all conditions rejoice in the achievements of the first half century of practical bacteriology. There is every reason to believe that with a better understanding of the vital relation of the microbial environment to higher forms of life bacteriology will be productive of still greater benefits, because of the education of the public concerning it and because of its more intelligent application by all.

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THE PALEONTOLOGICAL SOCIETY¹
ADDRESS OF THE PRESIDENT

THERE is a respectable virtue in the observance of well-tried usages. In the societies out of which we have emerged it

¹ Delivered by request at a joint meeting of this society and the Geological Society of America, Pittsburgh meeting, 1910.

has been the established procedure to penalize a retiring president with a somewhat formal address. It is a practise which is at once a solace and an opportunity; the former, inasmuch as successors to this honor of office must share these heart-searching efforts of its closing hours; an opportunity, for here is an outlet to unspoken cogitations which seldom take on the formal expression of the printed page, a chance to weave together the threads of evidence or suggestion we may have followed many years and left dangling; perhaps even, to perfect into some well-finished form the summation of our larger problems. It seems to have been tacitly assumed by our council and membership that I should inaugurate for this society the accustomed procedure anew. I frankly face this situation, but with no promise of the adequacy of the outcome.

I. At the outset I propose to take brief advantage of my own somewhat peculiar position and experience as a public official in paleontological science as a point of view from which but few of you, my audience, may have had opportunity to contemplate the subject. You will, I pray, be indulgent with this exploitation of a personal attitude, for it does seem to have certain complementary attributes which may in a way illuminate and supplement your own experience. If you find it a rather frank expression it will be couched in terms of fraternal regard, and I hope entirely devoid of unfair or invidious comment which might expose the writer to the charge of being a profane railer at the sanctities. My contact with the public of an intelligent and progressive government is now of rather long standing and this experience has been illuminating in any estimate of public sympathy with pure science.

It is safe to say that most of you are doing your work in the atmosphere of academic vales and cloisters where the prosecution of pure science is an elemental virtue. The very air you breathe is an inspiration to pursue any esoteric cult to any limit, howsoever far it may shape its course away from any apparent direct bearing on human happiness. An enlargement of human knowledge, even though already enlarged beyond human power to grasp, and the possibility of enlarging the comfort and hopes of mankind are justification for this pursuit, if justification be called for. Happily it is not needed, for the very next step, the scientific fact that lies unturned at our feet or the discovery just round the corner, may be as essential to philosophy and to progress as all that have passed by in their countless array. At your command is all that is best in the sciences and among your academic fellows in towns well oxygenated by the very air you exhale, you attain to the full measure of useful citizens. It might be trite for me to say that glorified with a splendid growth in the conservatory atmosphere of the university, the professor of science strays abroad from penetralia of his divinities with an acquired confidence of superiority, into a hardier air and a coarser grained world which declines to take him at his own valuation. I am disposed to think the sheltered aisles of great federal bureaus afford a very like protection from the assaults of the so-called practical community.

But take a man of pure science, and stand him out in the open where he must come into daily contact with men of affairs, men who are making a noise and doing that part of the world's work which feeds upon publicity, with the pulverizing wheels of political machinery and with the commercial sentiment which domi-

nates to-day more than ever before nearly every phase of government and nearly every aspect of society, and if he fails to take his own measure of so-called "practical" usefulness to his community of city or state, it is taken for him. If he can stand the shadowless glare of such an attitude he realizes at length that he is not indeed as other people are. By devotion to the duty his science imposes he may merit the confidence of his sponsors, but he is not likely to become the director of a bank or be invited to sit as a member of important fiduciary or social trusts. He is, in plain truth, quite generally regarded in the community as a rather unproductive if not visionary member of society with a large supply of useless knowledge but with a very limited capacity for making dollars, not always immaculate in his attire or particularly well groomed in person; somewhat terrifying socially, though harmless, perhaps, in his honest effort to turn a rather unintelligible hobby into the means of a livelihood. This expression is not, I think, an unfair phrasing of the general public attitude in our communities toward, not the man of pure science alone, but all high scholastic attainment. Notwithstanding the intellectual regeneration beginning with the last half of the last century which has tended to place all lines of human thought on a scientific basis, our best communities are still largely thinking deductively, and the rest entirely so whenever their thoughts have time to reach beyond their income; and we too may indeed confess freely and without shame even in this presence that something more of the prophet's vision, of the philosopher's method and of the poet's inspiration is stealing back into our own intellectual modes. You and I, men who are giving our best years and skilled energies to the elucidation of the organic law, the higher

law which alike makes the flower bloom and the philosopher think, the one law which governs all the world save only human society, are reasonably content in our security that we have chosen the good part and we decline to subject our standards to those of the eminently companionable and high-minded citizenry of the communities in which it has pleased God to place us.

Paleontology is, in my oft-asserted conviction, the most far-reaching of all the sciences. In it lies the root of all truth, out of it must come the solution of the complex enigmas of human society. Whatever it may be in the first instance, it is in the event that greatest study of mankind—man. It is the panoramic display of the life of the ages, the expression of the organic law of a hundred successive worlds. To quote the expression of Depéret: it has won its independence and is now marching hand in hand with biology toward the discovery of the history of the development of living beings and the laws which control their transformations. We unbar its doors and unlock its secrets only with the key of the present. To me it seems idle to fatuity to magnify the supposed imperfections in the record of life on the earths that have passed. Such efforts are constantly recurring, and when taken out of their proper setting are the last resort of the theorist and the special pleader. The known fauna and flora of the living earth is a percentage of the actual fauna and flora, and only in less degree is the known life of the past since Azoic time to the actual life of that past. The argument here has never been adequately presented, the facts never fairly marshalled, and we all too easily in our self confidence are wont to forget that after only a few brief years of study of the earth we still are standing at the threshold of the earth's history and

with a few facts in our possession grow impatient to habilitate the earth, while its deeper chambers still conceal records reserved for our successors to uncover. In the long ages which lie before the human race must come through greater wealth of knowledge a clearer view and more fruitful application of the truth we seek. To-day we begin to see the broad generalizations of the biologic law as based on paleontology which twenty years ago we believed so secure and illuminating, slowly yielding under the weight of accumulating evidence, and we should realize more deeply than ever and should, I believe, endeavor to leave the impress on our successors that it is still more knowledge that we require—it is still the facts we want, rather than the apparent inferences from those we have. Were demonstration of the propriety of this attitude required, let me venture to cite, as an interested onlooker, the enormous volume of unpublished data bearing on the life of Cambrian time which has been brought together by the secretary of the Smithsonian, facts which when known and assimilated must modify nearly every published conception of the development of life on the early earth. A few years ago at the opening of this century I ventured to address a personal letter to some ten men recognized as European leaders in geological work and thought, asking an expression as to what, in their judgment, would be the problems before the geologists of the coming generation. The replies were all alike in essence and reducible to this: The acquisition of more facts. To-day we see only through a glass darkly into our cathedral where the truth lies enshrined.

We know well enough, indeed it is a healthy sign that we are growing painfully conscious, that the standards of our best civilization are not those which have been

derived from a clear apprehension of the paramount law. We are certainly justified in our impatience with these standards so far as such impatience helps to make them or mankind better. Whoever seriously contemplates the historical development of our culture standards out of a barbaric past can hardly fail of restiveness under them, whether of our educational system with its burden of time-worn incongruities and maladaptation to highly differentiated individualities, in which to the common scandal of the race our youth have been treated as papers of pins, machine-made watches, or as communities of ants; of our various religions "with their mossy heritage of half truth and half fiction," of commerce with its Midas dreams and cut-throat ethics. But it is not likely that we can effect any perceptible influence upon these only as the pebbles of truth, brought together by the patient and persistent search which we pursue and encourage, cemented by the pervasive law of life, will some time make more secure the foundation for the superstructure of society. Men of science are freely accused to-day of a *snobisme scientifique*. The reproach comes pretty hard and fast from certain highly deductive quarters peopled largely by conventional thinkers. And it is not always in French, either. We may make all allowances for criticisms of our work based on a point of view quite inconceivable to consecutive inductive reasoning, but the fact is quite evident that scientific snobs and scientific snobbishness do abound. A clergyman of my acquaintance asked a scientific friend about his work—what vast problems were now occupying his mind, and with utter and quite needless frankness the answer was—Repairing the conclusions I arrived at last year. That quickly served to point a sermon on the errancy and frailty of inductive science.

But while the clergyman and the type of thought he stands for ought to know that progress in knowledge is never along direct lines, always in bewildering zigzags and pulsations which nevertheless end further forward than where they started, still the man of science does himself and his work an injustice in permitting himself to be exploited by agencies of popularization which are in essence entirely hostile to his mode of thought. So long as the whole pathway of science is bordered by the graves of cast-off theories and the atmosphere of to-day reeks with the aroma of new theories standing on probation and some in dire need of burial, it is wholesome to stop and reflect that these in their turn are likely to be inhumed with only rotting stones to mark the names of their progenitors.

We must recognize the fact that there is to-day a palpable reaction against the scientific mode for which we are ourselves to blame. The uplifting impulse given to every department of thought by the revival of the last decades of the nineteenth century is followed in this decade by a tremendous rebound. We may not all be fully conscious of this, as we are in some measure aloof from the pulse of other than scientific thought, but its proportions are well expressed by the formal and direct organization against the scientific mode embodied in such a masterly structure and so well-generated an army as the eucharistic congress. Let us not deceive ourselves, this great body of serious-minded deductive thinkers marshaled for no other purpose than to counteract the logical and the obvious and to encourage reliance on the mysterious is not standing alone. The ease with which we make and unmake hypotheses, the finality with which we enunciate propositions, the autocratic statement of possibilities as facts unques-

tionably tend to lead pure science into disfavor wherever the humanities are more prevalent. This unhappily growing disposition to finality of statement, forgetting that we are still watching only the first scene of our drama, is, I think, essentially at fault, and we are ourselves largely to blame for an evidently increasing indifference with which the autocratic theories of science are now received. Nothing fails in our philosophy, there is neither want of majesty or fullness of truth in our objective. But men of science need to mend their manners.

The vast majority of all our communities to-day are almost wholly abandoned to commercial pursuits. However this truth may be paraphrased, the euphemism of "making a living" applies to the absorbing share of human activities, instigates the volume of our legislation, controls our international relations, impregnates conceptions of the conservation of natural resources and lies at the base of all the comforts and conveniences of life which we now enjoy in unparalleled measure. Commerce has been the advance agent of civilization, has reduced the wilderness to an Hesperidean garden, is the seat and source of power of one over another, whether of individual, state or nation. To the advance of commerce both science and art are under tribute, but to the commercial spirit itself the human world owes no good thing, no higher thinking, no advance of vital truth, certainly no ethical progress. It is, like the lust of blood, a primitive impulse which still overpowers the race and it gives the reflecting man some notion of how short is the way he has traveled toward excellence and how long the road that lies ahead. "Science," says a recent writer, "means service." That is applied science in its relation to the state, and it is well. But "science" has a profounder phi-

losophy and blessed it is for humanity that the scientific *ideal* is sometimes wholly supreme and the *achievement* wholly incidental.

Experience and observation have deeply impressed me with the conviction that the most subtle intellect in our communities is that of the lawyer. I use the term only in its broadest and best sense. Trained to precise and consecutive thinking, averse to conclusions without full substantiation in fact or precedent, dealing with, at the bar, but perhaps, abhorring from the bench, hypotheses and reasonable presumptions, skilled in holding judgment in reserve and averse to dogmatic statement, the very intellectual practises which have effected these traits have helped to evolve a mental machine of extraordinarily delicate caliber and accurate register.

I can conceive of no finer training for a scholar of pure science than a course in the precedents and procedure of the law, if not carried too far, or if not that at least such intimate personal association with members of the legal profession as will help to irrigate the method of the scientific man with the mental prudence and reserve of the lawyer. Such a training would be better than Greek. The body of men that constitute the tribunals and the advocates in any country are the most influential element in conserving its culture. They are an anchor to windward. For human society they perform a function comparable only to that of the conservative mother in humanity; they ensure the perpetuation of the type.

But the lawyer is a dead wall to the progress of scientific truth. Deference to the common law, allegiance to the statute law, seem to have developed in him, both by training and association of ideas into the essentials of an instinct. We will not assume that the shortcomings of the con-

venances of the statutes are not more evident to him than to any other intellectual class in the community, or that he is blind to the mere expediencies of most legislation. Decent regard for the historic corpus of the law which embodies the experiences of self-governing people is essential to our community existence, but among the lawyers I have known best there seems to be ever a really inadequate apprehension of the essence of the law as expressed in Froude's definition of the term. "Our human laws," says Froude, "are but the copies, more or less imperfect, of the eternal laws so far as we can read them, and either succeed or promote our welfare, or tend to bring confusion and disaster, according as the legislator's insight has detected the true principle or has been distorted by ignorance or selfishness."

In fact, the natural law finds as yet feeble expression in our statutes. Certainly its recognized bearings are becoming incorporated into the laws of this land only as these recognized factors protect or guarantee the material rights of the people. But it is clear that neither the bare fact of legislation nor the decisions of the courts rest on any adequate conception of the workings of the natural law. Deference therefore to the written statute on the part of those whose intellectual energy is devoted to its interpretation or its execution, seems to have well-nigh suffocated the purpose to grasp the higher law on which governments built to endure must be established. Pure science which concerns itself in the search for the actual law regardless of its bearings on the present constitution of society, finds amongst this class in the community toleration, indeed, but little sympathy.

Of the three so-called learned professions in our early communities, the "doctors" constituted one. They do yet. To

them we owe a debt which can not be expressed. Their contributions to a knowledge of the biologic law are immense, far greater indeed than many of that profession realize. Speaking generally and broadly, it is fair to say that the physicians and surgeons of our community have worked out to approaching completeness the anatomy and functions of the most intricate and highly specialized member of the animal creation. It is probably true that, with brilliant exceptions, they have not often looked long or seriously into organic nature beyond or below man, nor sought the solution of his complicated morphology in its earlier expressions or in its history. No doctor of medicine or of human anatomy would have conceived a theory of natural selection or any other procedure of organic evolution. It was bound to come either from the student of pure biology or paleontology or from the poet. Starting at the top instead of the bottom of the ladder of life, by empirical methods fraught with immense consequence to humanity, they have solved many of the mysteries of life.

Concretely viewed, the appealing merit of their part in the revelation of the natural law lies in its contribution to human happiness by the relief of human misery but abstractly this application is of no concern in the philosophy of nature. The physical man is an item in the scheme of life and he would be audacious indeed who would say he was more. But it is the most compelling fact of existence that we are that item and it is our comfort and progress that has been and are to be largely ensured by these conservators of our being. We may smile with some degree of indulgence over this monopolistic trade-mark of doctor. You who have earned your doctorates in science or laws by long years of close application to arduous work will find

your achievement unrecognized by the doctor of medicine who acquired his degree by a three or possibly four years course in some medical school only possibly of respectable grade. In the community, outside of the university circle, you will be addressed by them as Mister, preferably as Professor, and if the latter, with apparently no other distinction in mind than that you are of a peculiar social genus which for convenience and to avoid infringement of copyright is so designated and with broad enough application to embrace with you the dancing master, the friseur and the artist in fistics. It is perhaps reasonably true that in any community deprived of the academic atmosphere, that is in the average American community, there is among practitioners of medicine and surgery an indifference to or failure to grasp the purport of pure biologic research, so complete and dense as to be appalling, the more as it lies in a quarter where one might most reasonably hope for support and sympathetic concern. Compared with the intelligent manufacturer, the wholesale merchant, the banker, the stock broker, the modern farmer, the average physician or surgeon carries toward the ideals of our science and of geologic science as well, so far as the results involved are not strictly commercial, an air of indifference that partakes of the supercilious.

These are the chief elements in our human atmosphere with which the work of some of us must most often come into close contact. As for the two influential classes—the clergy and the teachers—taken together as one class, the educators, it must be said that the reacting influence upon pure science is least of all. Either they lead where the student of biologic science can not follow or they follow where the biologist leads.

At the opening meeting of this society a year ago an effort was made to present as an introductory to our work the broader bearings of paleontologic science in a form which might be read and understood of all men. It was thought, and wisely, I believe, that in this way the society might declare at the outset a platform of helpfulness to the advance of human knowledge and thus to the progress of culture. Those of us who were privileged to listen to this conourse of authoritative expression on the achievements and potentialities of the science must have felt that such a summation of its purport was needed. I believe this society, now in its inception, would do well to keep before its eyes as the real objective of its existence, the fact that it must make itself immediately contributory to human culture and popular instruction if it is to achieve a worthy existence. In our varied special interests we are somewhat forced to overlook these broader and perhaps more humane applications in the conviction that our work is its own justification, no matter how constrained its boundaries. It is even so, but it was also a singular commentary I fear on the mental attitude of some of us toward what is really the supreme objective of our work that the council of this society decided not to publish this series of illuminating papers on the aspects of paleontology—and all the more a matter for congratulation that my successor to this office assured their publication in a magazine of wider and more popular circulation than the bulletin of the society.²

Rarely has there been given in any one place as satisfactory a summary of the philosophy and achievement of this sci-

²The papers delivered at the Conference on the Aspects of Paleontology at the first (Cambridge) meeting of the society have appeared in various numbers of *The Popular Science Monthly* for 1910.

ence. Competent men in all cases and in many equipped to speak with supreme authority, presented the propositions of the science from the point of view of their special lines of interest, and though on every topic brought under consideration much more might have been effectively said, yet the sum of the matter was to set before the mind, in part at least in imitable form, the scope of the science. The very nature and diversity of our interests are both our weakness and our strength. Our nature is trinitarian: whenever we cease to be held together by the centripety of a common broad unity, to keep our feet together on the platform of common concern, then we fly apart into our lesser orbits. If I could venture therefore out of my experience with the larger world, to urge one consideration of paramount concern on my successors in this office, it would be that on these occasions of annual reunion sight never be lost of our major purpose and no risk ever be invited of swamping our unity in the sea of details. Let us not blind ourselves to the beauty of the forest by seeing only the trees in it.

II. THE SIGNIFICANCE OF CERTAIN EARLY PARASITIC CONDITIONS

I propose now to turn your attention with reasonable brevity, and as a conclusion of this address, to a series of considerations which I am disposed to believe, when more fully illuminated by a patient and persistent accumulation of facts, may have a wider application to interests of immediate moment to society. In the acquisition of the evidences of the earliest phases of the parasitic or dependent condition of life I have been somewhat assiduous—enough at least to realize, as every one must in entering such a field, how much remains to be acquired and how many

illustrations of it still lie in our great museums unrecognized or unstudied. The appreciation of the parasitic conditions of to-day depends so wholly on the adaptations in the physiology and soft anatomy of organisms, that to seek such clues as these among the rocks may seem like entering a blind cavern without a torch. Volumes have been written and volumes more would be necessary to portray the aspects of dependent life in living nature from the simplest organic subjection among the bacteria to the most complicated expression in human society, and with these before our eyes I believe it possible eventually to resolve from the record of the past the problems of the origination of such dependent conditions.

Whatever attitude you and I may take as paleontologists toward the conceptions of Le Dantec and his followers, that the whole panorama of life is being renewed from its beginning every day in the scenes of the present world, these at least can not cover the transactions of organic dependence in which the time element is the most illuminating factor in its existence. What I have to offer at present is a very brief statement of a few suggestive facts and of certain justifiable inferences of broader scope which rank, I believe, in the category of continuous effects.

In the effort to find the real significance of this vital relation I have purposely confined my observations, so far as the fossils are concerned, to those within the Paleozoic. There have entered into the literature of fossil dependents straggling and usually quite incidental records of symbiosis in the eras later than the Paleozoic, but none of these eras which approach near to the present has added, so far as my knowledge extends, any essential clues to the origination of this condition. This is naturally so, for the advanced life of the Neozoic

times too closely approximates that of the present without carrying with it the solutions suggested by the soft bodies of to-day. Our statement of inferences in this problem must be very guarded because of our being bound down only to such records as the rocks have been able to retain. But lest these evidences be underestimated, let me insist that nature has dealt kindly in the retention of the most intimate structures and here again, so far as skeletal remains go, we can safely fall back on her beneficence.

Purely symbiotic mutualism is of very ancient date and we find frequent evidence of commensalism far back in Paleozoic faunas, of the same type of combinations as abound in the seas of to-day. Thus there are few commoner examples of mutual associations in the present sea than those of the worms and corals, the worms and sponges, sessile cirripeds and corals, and I have elsewhere indicated a number of such occurrences in the Paleozoic. There are the diffuse slightly curved tubes of the worm *Gitonia siphon* which traverse the fine-celled stratiform colonies of the coral Stromatopora in the Silurian and Devonian, the spiral worm Streptinodites of graceful form in the Silurian Stromatopora and one of heavier habit described by Calvin in the large-celled coral Acervularia of the middle Devonian. The open apertures of tubes of *Gitonia coralophila* are often to be seen projecting from the cups and even the sides of the coral *Zaphrentis* and its allies. These are simple associations in which the partners are and have always been equally and mutually dependent, both having begun life as independent free swimming beings. Among these commensal worms and corals there is one association that invites particular notice in passing, for so far as I know the present fauna, its parallel is not

recorded. This is the compound coral *Pleurodictyum* and its worm *Hicetes*—an association long known to students of the Devonian, but not till recently, with the help of carefully prepared materials fully comprehended. *Pleurodictyum* is a compound favosite growing in small, large-celled lens-shaped coralla of the size of a brussels sprout. Its commonest species are *Pleurodictyum problematicum* of the European Coblenzian and *Pleurodictyum styloporum* of the Hamilton shales of America. The sessile thecated base of the corallum in both these species seems to have attached itself to the rock or mud of the sea bottom in a way that involved the formation of no special cicatrix or scar of attachment. My observations lead me to the conclusion that in the Coblenzian species such form of attachment occurred in about one half of the individuals and in perhaps somewhat less than one half in the Hamilton species. The rest attached themselves at the beginning of the sessile stage to some organic object, some dead shell on the sea bottom. In the Hamilton species in approximately one fifth of the cases, this dead shell was usually a gastropod of the genus *Pleurotomaria* or *Cyclonema*; in the remaining four fifths, the shell was always the same shell, a species of the gastropod *Loxonema (delphicola = hamiltonensis)*. I have not recorded an instance of the coral being attached to any other than a gastropod, shell. These are rather broad statements but are based on the examination of several hundred examples and are an approximate expression. These bases of attachment were of course dead shells which the free-swimming coral larvae selected. I have italicized the word "selected" as, however else one may be disposed to interpret the phenomenon, the act bears a strange resemblance to conscious choice. The Coblenzian *Pleurodictyum* so similar in struc-

ture as almost to veil specific difference, has however chosen differently. I can not say that I have seen a wholly convincing number of German specimens, though probably I have had opportunity, by the help of collectors and the collections of many museums, of seeing as many as any one else, and I have further had the benefit of accounts given by various workers. An approximate half of the German specimens, rather more than less, are unattached. For the remainder I have seen none that is not attached to the brachiopod *Chonetes sarcinulatus*.³ However these very strange facts may be expressed in accurate percentages, the palpable evidence remains, that the free and independent larvae of these closely allied species of the same genus of coral have in one part of the world unerringly taken a brachiopod shell for a *pou sto*, while in another perhaps actually coeval sea they have not chosen a brachiopod but always a gastropod, and usually one and the same species of gastropod, for their sedentary maturity.

Neither of these species of coral embryos was deprived of a choice. The sea bottom of the Coblenzian and of the Hamilton stages teemed with all varieties of invertebrate remains. Gastropods and brachiopods flourished alike on both. An act of choice could not pertain to the degenerate and fixed adult condition of growth; but it is a matter of supreme interest that such an apparent act, in whatever psychological category it may find its place, did manifest itself in the higher stage of normal inheritance, the free and independent condition of early life.

I presume that in all the phenomena of commensalism which the early faunas of

³ *Pleurodictyum* of like Devonian age and with its *Hicetes* occurs both on the Bosphorus and the Maecurú River, Brazil, but we know nothing yet of its habit of fixation.

the earth have exhibited, the concurrence of the worm and the coral is the commonest. Yet I have not observed it in faunas earlier than the Silurian, with possible reservation for the Ordovician. The Cambrian faunas contain the vital elements necessary for such cohabitation, but have not shown any indication that this habit of interdependence had been formed so early, even though the degenerate condition of attachment had been abundantly acquired then and doubtless long before⁴ I shall not enter into needless detail regarding other mutual associations of these early days, citing briefly, for convenience of reference to those who are interested, the cases of the corals *Favosites* and *Amplexus* recorded from the Niagaran of Iowa, of a worm in the bodies of the glass sponges, *Hydnoceras* and *Prismodictya* of the upper Devonian, of the barnacle *Paleocreusia* in a colony of *Favosites*, from the lower middle Devonian Onondaga limestone.

In late stages of the Ordovician there are certain crinoids of the genus *Glyptocrinus* and other long-armed inadunates which when found with arms drawn together hold within them a round-mouthed snail shell of the genus *Cyclonema*. I have examined a number of these associations, but have seen in none of this age any evidence of actual attachment of the shell to the proct or any other part of the crinoid. Evidently here the association was a loose one, the snail feeding on the fecal waste of the crinoid, hanging around the back door like a dog at a garbage pail. It was not long after the inception of this habit, however, that an actual fixation ensued, and there are well-known cases in the faunas of the Silurian of both crinoids and cystids cemented by a muscular attachment over the proct of the host, so firmly as to hold

⁴ At this meeting of the society Dr. C. D. Walcott exhibited specimens of a Cambrian worm commensal with medusa.

its place during all the procedure of fossilization. We can not say how enduring this condition of deject dependence was in the life of the individual of the Silurian, but the Devonian faunas and more especially those of the early Carboniferous when the crinoidea attained their maximum profusion, at once furnish abundant and well-known facts indicating that this habit had at least become so fixed that it began with a very early juvenile stage and continued probably till released by death. The domes of many crinoids in these faunas have shown by successive elliptical scars, of which the proct is the focus, left by growing shells, that the snail remained permanently and solidly devoted to this habit for probably all the later stages of its life. This is distinctly a case of true parasitism; not merely of that degeneration resulting from dependence which is universal in nature, but of absolute and abject dependence on the vital functions of another. During the maximum of the crinoids as well as of these capulids or limpets in the early Carboniferous time the attachment seems to have been not occasional, but to have attained the character of an actual habitude to which all members of the Capulidae were liable even though not all really practised it. This singular condition endured during millions of years from its inception in the Silurian to its climax, but from the time of its general prevalence in the early Carboniferous on through the closing stages of the Paleozoic and through the long following ages up to the present we seem to lack any shred of evidence of its continuation. In very fact it seems as if in the long panorama of life through the varying phases of this great time interval, for the first time in all our knowledge of the parasitic life in all circles of existence (except where this has been influenced by the higher

motives which govern humanity), that here nature had demonstrated the power in herself to rebound from such tendencies to degeneration, to give her creatures a sharp turn about and start them again on the upward path. What a splendid significance of salvation it would be for the tremendous majority of nature's apparently doomed races if there should lie herein even a slender ray of hope for the recovery of tendencies toward the normal upward progress which so many organisms have lost by the supervention of degenerate habits. We may not be entirely sure that this ray of hope for a lost nature really exists, for even though we have no evidence of the parasitic dependence of the gastropods upon the Echinoderma in all the ages of the Mesozoic and the Cenozoic, we do know that in the present sea all parasitic gastropods are parasites on the Echinoderma, the class to which the crinoids belong.

Crinoids are few to-day; to my knowledge no one has recorded on them the presence of parasitic snails, but their close relatives, the star-fish and sea urchins, are still beset by gastropods, often so modified by their degeneracy that their nature is hardly recognizable, and this parasitism too is fixed and beyond repair. In these cases which have been particularly studied by the Sarasin brothers, the parasite is still of the limpet type of structure, whether the host be starfish or sea urchin. There is a palpable vast difference in degree between this particular form of parasitism to-day and the association of limpet and crinoid in the days of the Carboniferous seas, the later irremediable, the earlier still not beyond repair, well established but clearly not beyond the control of the dependent. The great gap of positive evidence in the profoundly studied Mesozoic and Tertiary faunas which certainly should have af-

forsaken such factors had they ever existed, leaves us a reasonable propriety to construe the cessation of this parasitism as actually accomplished in Carboniferous times, and the recurrence of like associations among allied animals of the present an essentially new adaptation of the two. For nature has made these adaptations easily and degeneracy to the parasitic condition is one of the facile procedures of life, moving on apace with ever-increasing momentum toward race destruction. Much more natural, much more logical, much better justified by well-known procedure in these easy adaptations, is such a proposition, than that after millions of ages of suppression the ancient abject dependence of the limpet on the crinoid should have reappeared as a direct inheritance out of the remote past. It is to this point I would direct the major purport of this paper, for aside from all other questions of ancient parasitic conditions there is none yet of so profound biologic significance as this question raised by the parasitism of the Paleozoic gastropods on the crinoids. Did the snails get over it? Did they conquer this habit of dependence and return to normal independence? Granted that the parasitic condition is but an expression of adaptation; yet it unfailingly involves degeneration. Did the gastropod rebound from its degenerate adaptation and return toward the normal living which has helped to perpetuate its stock abundantly to the present in more self-reliant expression? I believe that all the positive and all the negative evidence we can now adduce on this deeply important subject favors the presumption that the habit was abandoned or at least, to speak in terms of simple casuistry, was lost. We may give the counter proposition all the weight to which it is entitled, and I believe we ask too much of both evidence and presumption

to seek in it a recrudescence of a transmitted acquired habit in the present after the lapse of untold millions of years between its appearances.

Living nature can of its very essence present us with no such proposition as this. Here the time element is of paramount importance and we are confronted then here by the single example in all known nature below man of the possible recovery of a normal upright tendency in organic living after a period of degeneration, of a case of what appears to be, deducting due allowance for possible uncovered records among profoundly studied geological faunas, an actual rebound from an adaptation to evil living back to the normal uprightness of independent life by the intervention of natural forces only. I might cite to you additional interesting cases of the parasitic habit in Paleozoic organisms, but none which can now amplify the special point I have had in mind in bringing these succinctly to your notice. For doubtless if nature could and did turn even an invertebrate sinner from the error of its ways once, she can do it again; she doubtless has done it more than once and her influences directed toward the demolition of such degenerating adaptations could not be restricted solely to lowly forms of life. The supreme merit of the striking illustration I have been able to bring to your attention lies in the panorama of its history, its inception, its progress, climax and probable extinction. Even though it may now stand alone, the argument from it could not be much altered nor greatly strengthened by supplementary cases, however it might be clarified by the verification of the negative evidence in the ages between the Paleozoic and the present. But so far is the evidence good and the logic sound that I need not hesitate to intimate that the parallelism between organic

and social parasitism is not a similitude. Organic degeneracy and degeneracy in human society are not, I take it, a mere equivalence in terms, but a result in effects through stages of adaptation entirely comprehensible. Sin, then, the expression of degeneracy, we may reasonably hope to believe and perhaps eventually to demonstrate from the facts of our science, is an error whose cure may lie within our own inherent impulses and whose existence may be terminated with the stronger growth of our intellectual and moral perceptions entirely within the sphere of nature herself.

JOHN M. CLARKE

THE DISTRIBUTION OF THE COLLEGE MEN

THE *Yale News* has made an analysis of "Who's Who in America" for 1910-11 and finds in the book the names of 8,529 college men. The data for fourteen institutions are given as follows:

	Law	Medicine	Education	Science	Engineering	Ministry	Writing	Mining	Eng.	Journalism	Finance and Business	Government Service	Retired	Total
Harvard..	158	92	175	111	25	48	77	6	59	41	43	15	813	
Columbia..	62	29	53	32	13	19	14	7	10	15	7	—	261	
Yale.....	130	51	131	71	24	84	49	4	43	41	42	10	681	
Michigan..	57	28	69	47	12	9	17	2	8	8	24	10	271	
Virginia..	38	19	27	11	2	8	2	—	1	2	11	1	122	
Wesleyan..	14	3	37	12	2	32	4	—	6	1	7	3	121	
Princeton..	50	20	41	11	3	46	14	1	17	8	8	1	210	
R. P. I....	2	—	—	1	14	—	—	—	—	—	—	—	—	17
Amherst..	23	10	65	29	5	36	12	—	10	9	4	2	205	
Williams..	21	5	27	10	1	30	8	—	9	4	7	1	123	
Chicago...	10	5	32	18	—	7	4	—	4	5	2	2	1	88
M. I. T....	—	3	4	16	20	1	3	—	2	2	—	—	—	52
Cornell ...	15	9	38	39	27	7	11	—	10	3	5	3	167	
Penn	32	53	29	18	11	15	10	3	11	4	9	3	200	

SCIENTIFIC NOTES AND NEWS

THE officers of the American Museum of Natural History, who were elected at the annual meeting of the board, held February 13, 1911, are as follows: *President*, Henry Fairfield Osborn; *First Vice-president*, Cleveland H. Dodge; *Second Vice-president*, J. Pierpont Morgan, Jr.; *Treasurer*, Charles Lanier; *Secretary*, Archer M. Huntington; *Acting*

Director, Charles H. Townsend; *Assistant Treasurer*, United States Trust Company of New York; *Assistant Secretary*, George H. Sherwood. By unanimous vote of the trustees, Professor Bashford Dean, Columbia University, was reinstated in his post as curator of ichthyology and herpetology. The trustees also promoted Dr. W. D. Matthew from acting curator to curator of the department of vertebrate paleontology. Barnum Brown, assistant curator of fossil reptiles and Walter Granger, assistant curator of fossil mammals, become associate curators.

FOR the meeting of the British Association for the Advancement of Science, which is to take place this year at Portsmouth on August 30 and following days, under the presidency of Professor Sir William Ramsay, K.C.B., F.R.S., the following presidents have been appointed to the various sections: *Mathematical and Physical Science*, Professor H. H. Turner, D.Sc., F.R.S.; *Chemistry*, Professor J. Walker, D.Sc., F.R.S.; *Geology*, A. Harker, M.A., F.R.S.; *Zoology*, Professor D'Arcy W. Thompson, C.B.; *Geography*, Col. C. F. Close, R.E., C.M.G.; *Economic Science and Statistics*, Hon. W. Pember Reeves; *Engineering*, Professor J. H. Biles, LL.D.; *Anthropology*, Dr. W. H. R. Rivers, F.R.S.; *Physiology*, Professor J. S. Macdonald; *Botany*, Professor F. E. Weiss, D.Sc., with W. Bateson, F.R.S., as *chairman of the Sub-section of Agriculture; Educational Science*, Rt. Rev. J. E. C. Welldon, D.D.

A PORTRAIT of Sir William Crookes by Mr. E. A. Walton, has been presented to the Royal Society.

PROFESSOR D. OLIVER, F.R.S., formerly keeper of the herbarium and library of the Kew Gardens, known for his important contributions to botany, celebrated his eightieth birthday on February 5.

MEMBERSHIP in the Prussian House of Lords has been conferred on Dr. Wilhelm Waldeyer, professor of anatomy in the University of Berlin.

THE gold medal of the Royal Astronomical Society has been presented to Dr. P. H.